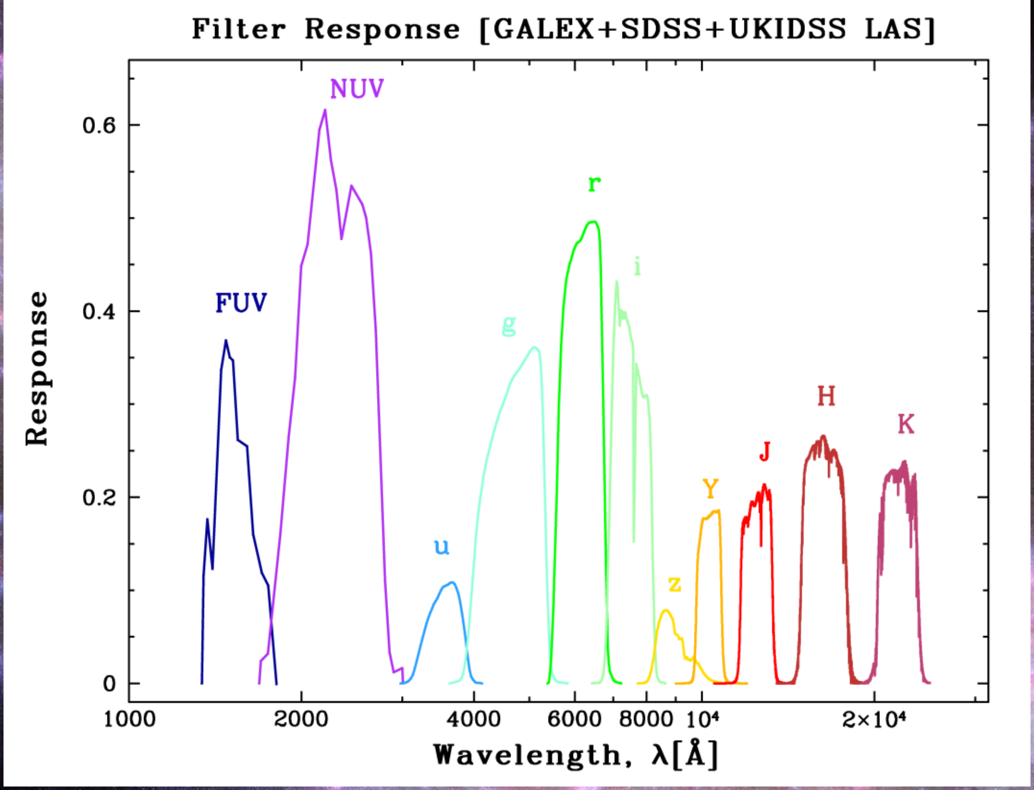
Multi-wavelength Properties of SN Ia Host Galaxies



Ravi Gupta
with Masao Sako (*UPenn*)
and Charlie Conroy (*CfA*)

SDSS-II Supernova Collaboration Meeting
Argonne National Labs
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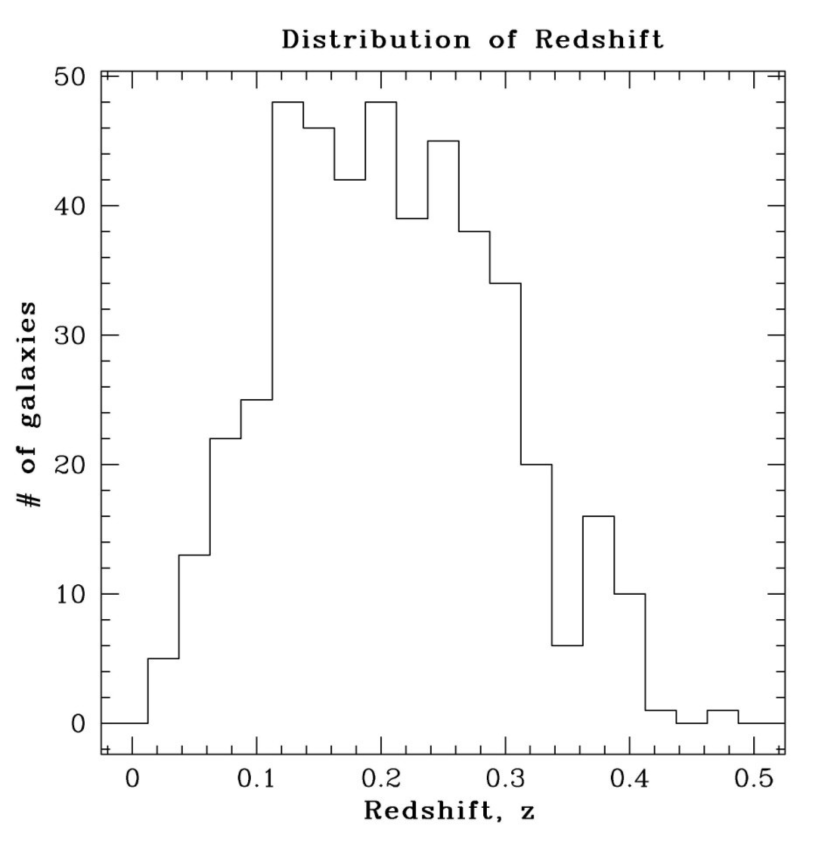
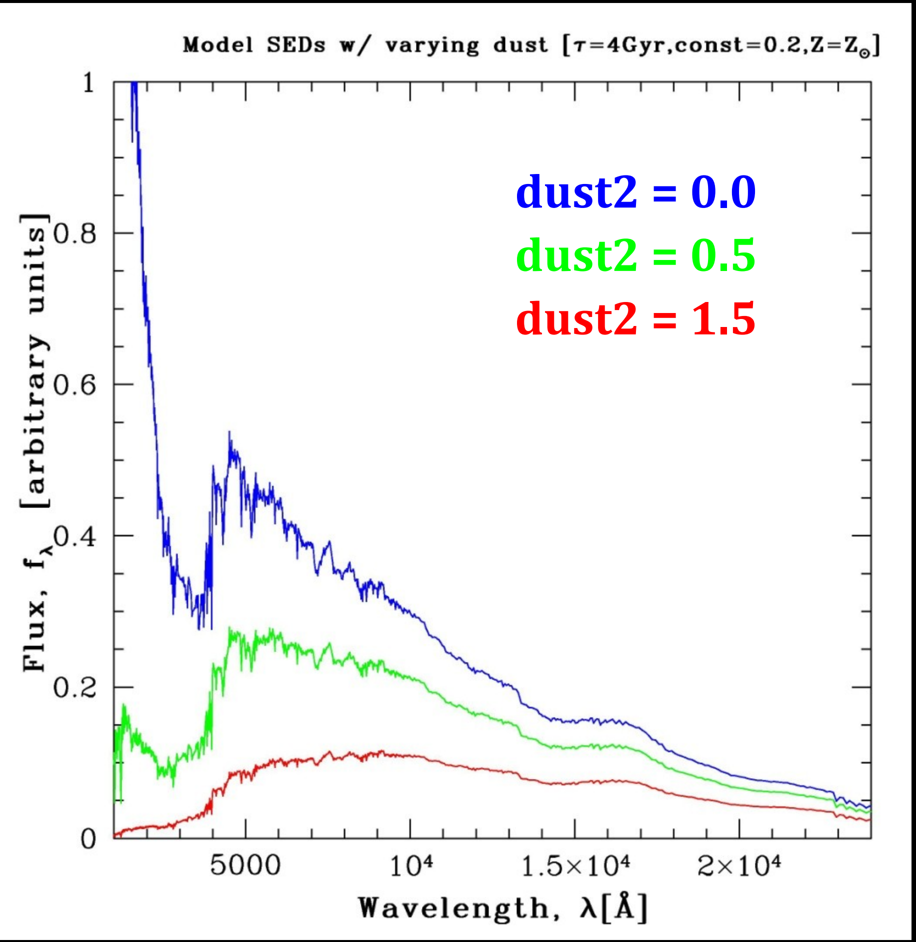
Data Sample

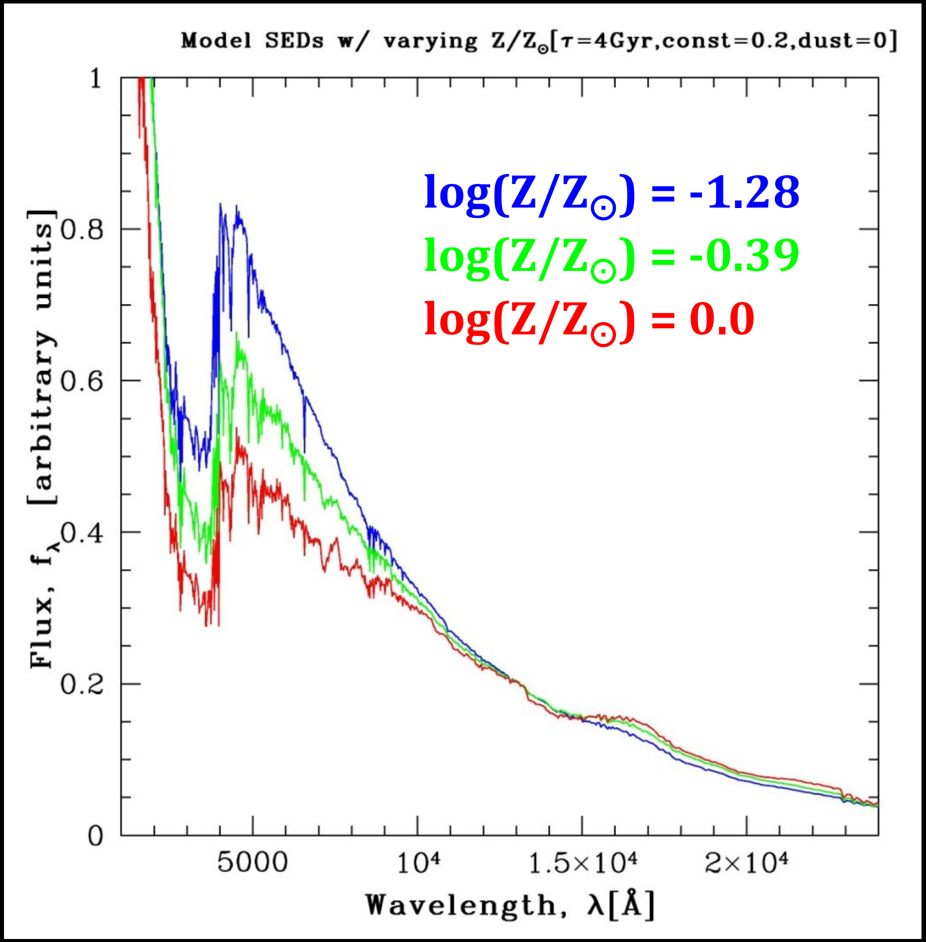
- 459 SDSS galaxies identified as hosts for the spectro-scopically confirmed SNe Ia found in SDSS-II Supernova Survey [0.01 < z < 0.48]
- 272 of these 459 (59%) have UKIDSS matches within a 5″ radius
- 192 (42%) GALEX matches within a 5″ radius



→ GALEX [UV] + SDSS [optical] + UKIDSS [near-IR] photometry

The Effect of Dust & Metallicity





UV data helps constrain metallicity & recent SFR while near-IR data probes dust & the older stellar populations that compose a large portion of the mass

Method

- Generate grid of models parameterized by metallicity, dust, and star-formation history using **Flexible Stellar Population Synthesis** code of *Conroy, Gunn, & White 2009*

Minimum χ^2 grid search:

- For each galaxy, convert observed magnitudes to AB system, correct for MW extinction, then convert magnitudes & corresponding errors to flux
- Perform χ^2 analysis, comparing data fluxes with each of the model fluxes
- Take the minimum-χ^2 model to be the best-fit model

Model Fit Parameters

- Metallicity, *Z* (assumed constant for each model)
- Attenuation of old stellar light, *dust2*

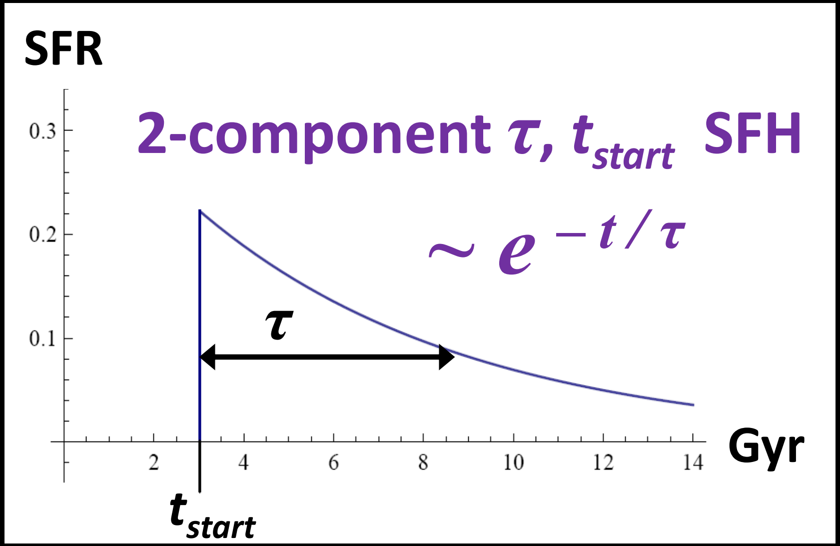
  Attenuation described by exp(-τ_λ(t)), where τ_λ(t) is the optical depth given by the 2-component dust model of Charlot & Fall (2000):

$$\tau_\lambda(t) \equiv \begin{cases} \tau_1(\lambda/5500\ \text{Å})^{-0.7} & t \leqslant 10^7\ \text{yr} \\ \tau_2(\lambda/5500\ \text{Å})^{-0.7} & t > 10^7\ \text{yr} \end{cases}$$

dust2

Fix *dust1* = 3 *dust2* (Kong et al. 2004)

- Exponential decline rate of SFR, τ
- Time of initial star formation, t_{start}



Parameter Grid

$\log(Z/Z_\odot)$	-0.88, -0.59, -0.39, -0.20, 0, 0.20
dust2	0, 0.1, 0.3, 0.5, 1.0, 1.5
τ (Gyr)	0.1, 0.5, 1, 2, 3, 4, 6, 8, 10
t_{start} (Gyr)	0, 1, 2, 3, 4, 5, 6, 7

2592 MODELS

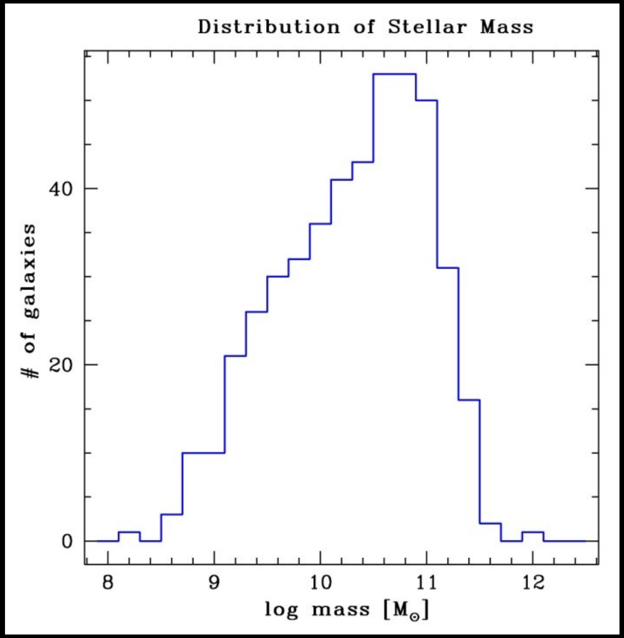
Derived Galaxy Properties

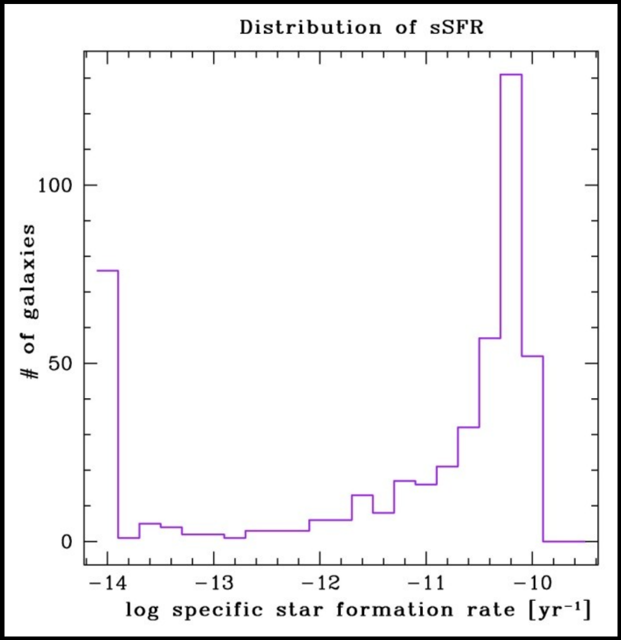
For each galaxy we derive 3 properties:

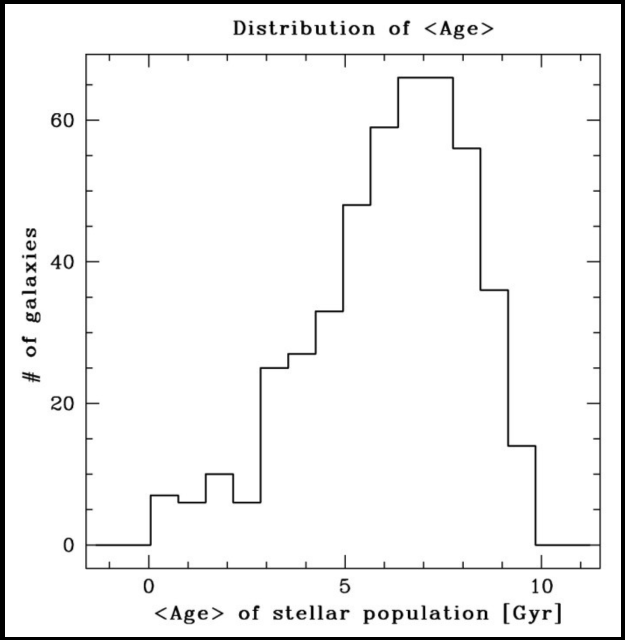
- ***stellar mass* –** multiply the observed luminosity in the *r* band by the model M/L in the same band
- ***current average specific star formation rate (sSFR) –*** average SFR(t) over the past 0.1 Gyr
- ***average age of stellar population –*** $\dfrac{\int t \times \mathrm{SFR(t)dt}}{\int \mathrm{SFR(t)dt}}$

For each galaxy, we calculate the median mass, sSFR, age and the corresponding uncertainties from the probability distribution obtained from likelihoods

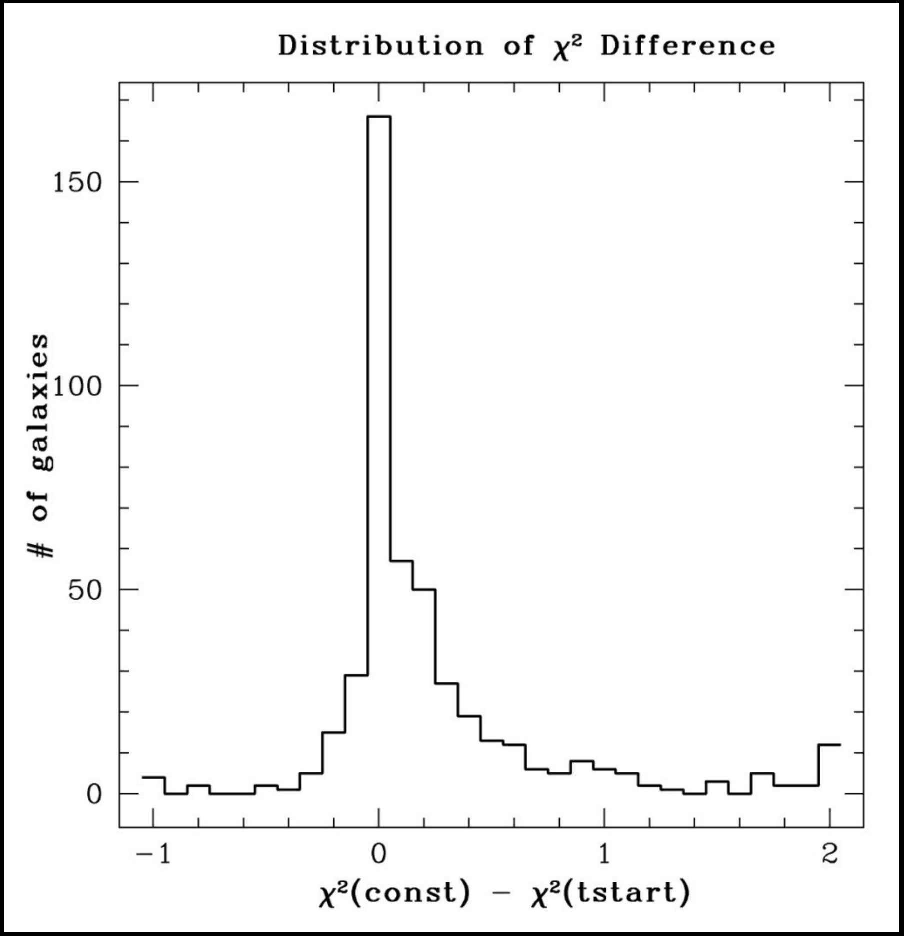
Galaxy Properties: Results

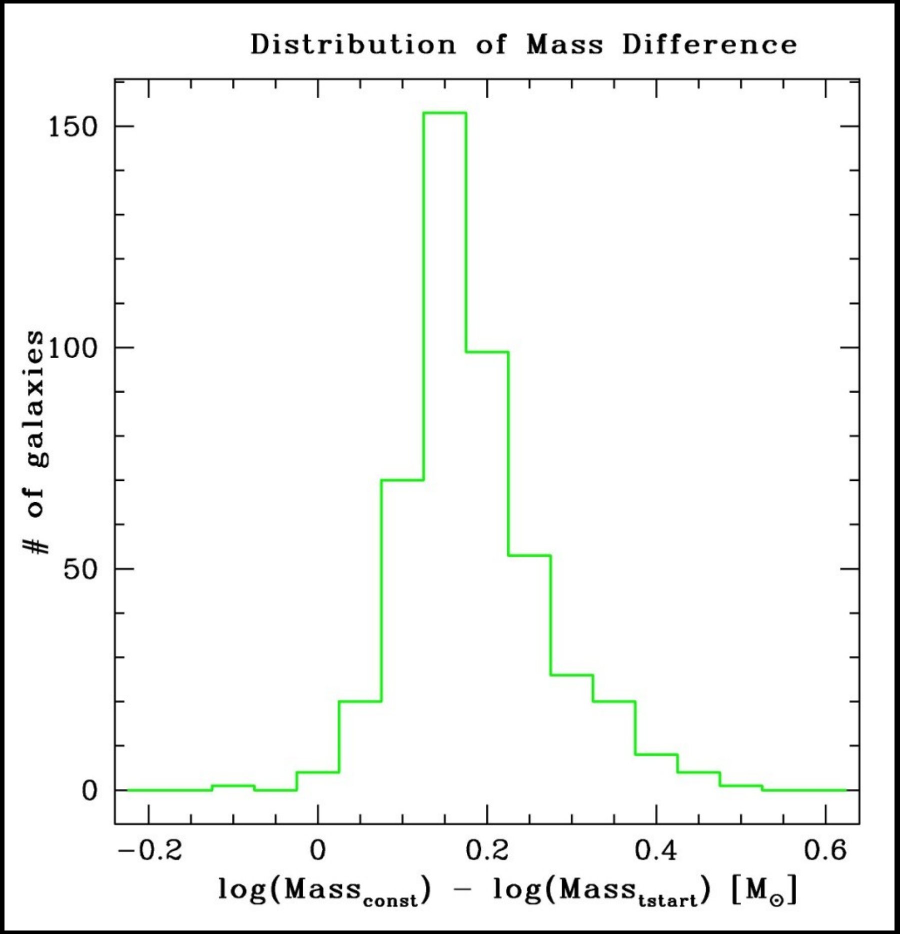




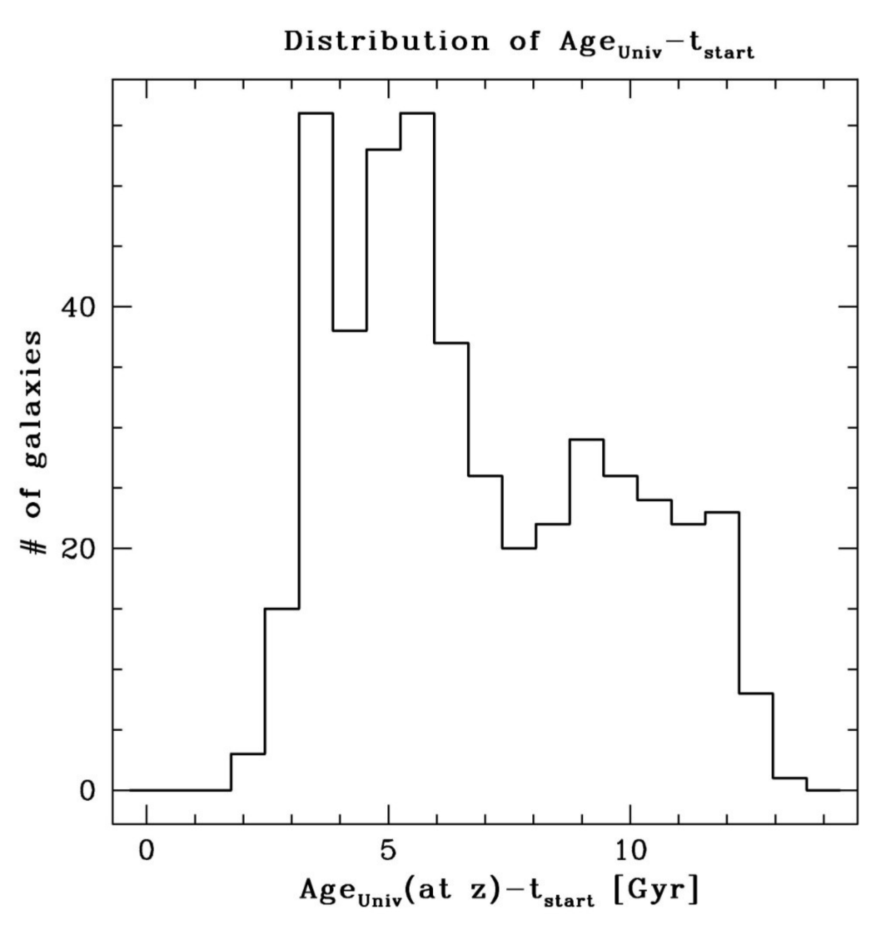


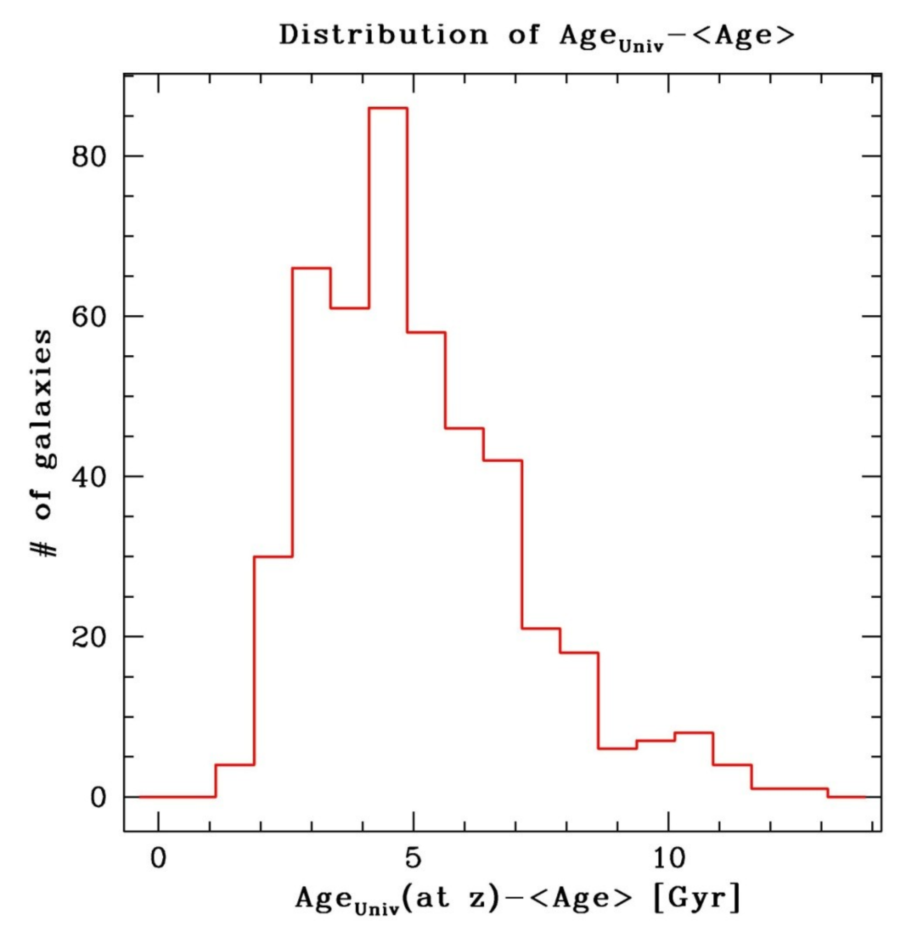
Effect of New Star Formation Rate





“Delay Time Distribution”

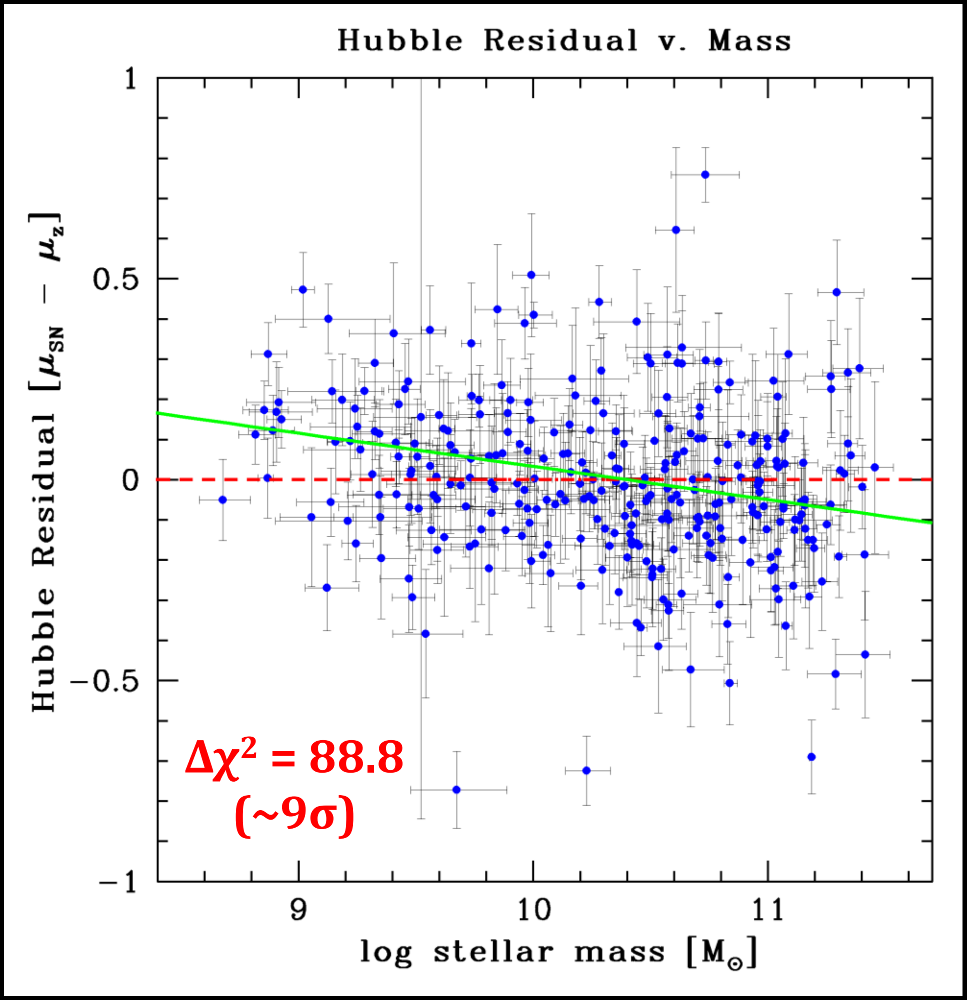




SN Ia Properties

- Used MLCS2k2 [*Jha et al. 2007*] to obtain SN Ia properties (Δ, μ, A_V)
- Look for correlations between host galaxy properties and SNe Ia properties
- If observed variations in SNe Ia are due to environmental factors or systematics, it would have important implications for cosmology and the use of SNe Ia as “standard candles”

SN Properties vs. Galaxy Properties



We also find evidence that more massive galaxies seem to host brighter SNe after light-curve correction [*Kelly et al. 2010; Sullivan et al. 2010; Lampeitl et al. 2010*]

HR > 0 indicates SN is fainter *after* light-curve correction

Summary & Future Work

- Stellar masses, sSFRs, and ages for 459 SN Ia host galaxies estimated from multi-wavelength photometry
- Confirmed trend of mass with Hubble residual; continuing to look for SN-galaxy correlations
- Further investigate delay time
- Use available spectra to better constrain metallicity and SFR (Chris D’Andrea)